DAEDALUS
OR
SCIENCE & THE FUTURE

By
J. B. S. HALDANE

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Science and the Future

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BY

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INTRODUCTION

I have slightly expanded certain parts of this paper since reading it. It has therefore probably lost any unity which it may once have possessed. It will be criticized for its undue and unpleasant emphasis on certain topics. This is necessary if people are to be induced to think about them, and it is the whole business of a university teacher to induce people to think.

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DAEDALUS
OR
SCIENCE AND THE FUTURE

As I sit down to write these pages I can see before me two scenes from my experience of the late war. The first is a glimpse of a forgotten battle of 1915. It has a curious suggestion of a rather bad cinema film. Through a blur of dust and fumes there appear, quite suddenly, great black and yellow masses of smoke which seem to be tearing up the surface of the earth and disintegrating the works of man with an almost visible hatred. These form the chief parts of the picture, but some where in the middle distance one can see a few irrelevant looking human

figures, and soon there are fewer. It is hard to believe that these are the protagonists in the battle. One would rather choose those huge substantive oily black masses which are so much more conspicuous, and suppose that the men are in reality their servants, and playing an inglorious, subordinate, and fatal part in the combat. It is possible, after all, that this view is correct.

Had I been privileged to watch a battle three years later, the general aspect would have been very similar, but there would have been fewer men and more shell-bursts. There would probably, however, have been one very significant addition. The men would have been running, with mad terror in their eyes, from gigantic steel slugs,

which were deliberately, relentlessly, and successfully pursuing them.

The other picture is of three Europeans in India looking at a great new star in the milky way. These were apparently all of the guests at a large dance who were interested in such matters. Amongst those who were at all competent to form views as to the origin of this cosmoclastic explosion, the most popular theory attributed it to a collision between two stars, or a star and a nebula. There seem, however, to be at least two possible alternatives to this hypothesis. Perhaps it was the last judgment of some inhabited world, perhaps a too successful experiment in induced radio-activity on the part of some of the dwellers there. And perhaps also these two hypotheses are

identical, and what we were watching that evening was the detonation of a world on which too many men came out to look at the stars when they should have been dancing.

These two scenes suggest, very briefly, a part of the case against science. Has mankind released from the womb of matter a Demogorgon which is already beginning to turn against him, and may at any moment hurl him into the bottomless void? Or is Samuel Butler's even more horrible vision correct, in which man becomes a mere parasite of machinery, an appendage to the reproductive system of huge and complicated engines which will successively usurp his activities, and end by ousting him from the mastery of this planet? Is the machine-minder engaged on

repetition-work the goal and ideal to which humanity is tending? Perhaps a survey of the present trend of science may throw some light on these questions.

But first we may consider for a moment, the question of whether there is any hope of stopping the progress of scientific research. It is after all a very recent form of human activity, and a sufficiently universal protest of mankind would be able to arrest it even now. In the middle ages public opinion made it so dangerous as to be practically impossible, and I am inclined to suspect that Mr. Chesterton, for example, would not be averse to a repetition of this state of things. The late M. Joseph Reinach, an able and not wholy illiberal thinker, publicly advocated it.

I think, however, that so long as our present economic and national systems continue, scientific research has little to fear. Capitalism, though it may not always give the scientific worker a living wage, will always protect him, as being one of the geese which produce golden eggs for its table. And competitive nationalism, even if war is wholly or largely prevented, will hardly forego the national advantages accruing from scientific research.

If we look at the other most probable alternative the prospect is little more hopeful. In this country the labour party alone among political organizations includes the fostering of research in its official programme. Indeed as far as biological research is concerned

labour may prove a better master than capitalism, and there can be little doubt that it would be equally friendly to physical and chemical research if these came to lead immediately to shortened hours rather than to unemployment. In particular there is perhaps reason to think that that form of sentimentalism which hampers medical research in this country by legislation would be less likely to flourish in a robust and selfish labour party of the Australian type than in parties whose members enjoy the leisure which seems necessary to the development of such emotional luxuries.

It is of course possible that civilisation may collapse throughout the world as it has done in parts of Russia, and science with it, but such an event would

in all probability, only postpone the problem for a few thousand years. And even in Russia we must not forget that first-rate scientific research is still being carried on.

The possibility has been suggested—I do not know how seriously—that the progress of science may cease through lack of new problems for investigation. Mr. Chesterton in *The Napoleon of Notting Hill,* a book written fifteen years or so ago, prophesied that hansom-cabs would still be in existence a hundred years hence owing to a cessation of invention. Within six years there was a hansom-cab in a museum, and now that romantic but tardy vehicle is a memory like the trireme, the velocipede, and the 1907 Voisin biplane. I do not suggest that Mr.

Chesterton be dragged—a heavier Hector—behind the last hansom cab, but I do contend that, in so far as he claims to be a prophet rather than the voice of one crying in the wilderness, he may be regarded as negligible for the purpose of our discussion. I shall try shortly to show how far from complete are any branches of science at the present time.

But first a word on Mr. H. G. Wells might not be out of place. The very mention of the future suggests him. There are two points which I wish to make about Mr. Wells. In the first place, considered as a serious prophet, as opposed to a fantastic romancer, he is singularly modest. In 1902, for example, in a book called "Anticipations," he gave it as his personal

opinion that by 1950 there would be heavier than air flying machines capable of practical use in war. That, said he, was his own view, though he was well aware that it would excite considerable ridicule. *I propose in this paper to make no prophecies rasher than the above.*

The second and more important point is that he is a generation behind the time. When his scientific ideas were formed, flying and radiotelegraphy, for example, were scientific problems, and the centre of scientific interest still lay in physics and chemistry. Now these are commercial problems, and I believe that the centre of scientific interest lies in biology. A generation hence it may be elsewhere, and the views expressed in this paper will

appear as modest, conservative, and unimaginative as do many of those of Mr. Wells to-day.

I will only touch very briefly on the future of physics, as the subject is inevitably technical. At present physical theory is in a state of profound suspense. This is primarily due to Einstein—the greatest Jew since Jesus. I have no doubt that Einstein's name will still be remembered and revered when Lloyd George, Foch, and William Hohenzollern share with Charlie Chaplin that ineluctable oblivion which awaits the uncreative mind. I trust that I may be excused if I trespass from the strict subject of my theme to add my quota to the rather numerous mis-statements of Einstein's views which have appeared during the last few years.

Ever since the time of Berkeley it has been customary for the majority of metaphysicians to proclaim the ideality of Time, of Space, or of both. But they soon made it clear that in spite of this, time would continue to wait for no man, and space to separate lovers. The only practical consequence that they generally drew was that their own ethical and political views were somehow inherent in the structure of the universe. The experimental proof or disproof of such deductions is difficult, and—if the late war may be regarded as an experimental disproof of certain of Hegel's political tenets —costly and unsatisfactory.

Einstein, so far from deducing a new decalogue, has contented himself with deducing the consequences to space and

time themselves of their ideality. These are mostly too small to be measurable, but some, such as the deflection of light by the sun's gravitational field, are susceptible of verification, and have been verified. The majority of scientific men are now being constrained by the evidence of these experiments to adopt a very extreme form of Kantian idealism. The Kantian *Ding-an-sich* is an eternal four-dimensional manifold, which we perceive as space and time, but what we regard as space and what as time is more or less fortuitous.

It is perhaps interesting to speculate on the practical consequences of Einstein's discovery. I do not doubt that he will be believed. A prophet who can give signs in the heavens is always believed. No one ever seriously

questioned Newton's theory after the return of Halley's comet. Einstein has told us that space, time, and matter are shadows of the fifth dimension, and the heavens have declared his glory. In consequence Kantian idealism will become the basal working hypothesis of the physicist and finally of all educated men, just as materialism did after Newton's day. We may not call ourselves materialists, but we do interpret the activities of the moon, the Thames, influenza, and aeroplanes in terms of matter. Our ancestors did not, nor, in all probability, will our descendants. The materialism (whether conscious or sub-conscious does not very much matter) of the last few generations has led to various results of practical importance, such as sanitation,

Marxian socialism, and the right of an accused person to give evidence on his or her own behalf. The reign of Kantian idealism as the basal working hypothesis, first of physics, and then of every-day life, will in all probability last for some centuries. At the end of that time a similar step in advance will be taken. Einstein showed that experience cannot be interpreted in terms of space and time. This was a well-known fact, but so long as space and time did not break down in their own special sphere, that of explaining the facts of motion, physicists continued to believe in them, or at any rate, what was much more important, to think in terms of them for practical purposes.

A time will however come (as I

believe) when physiology will invade and destroy mathematical physics, as the latter have destroyed geometery. The basic metaphysical working hypothesis of science and practical life will then, I think, be something like Bergsonian activism. I do not for one moment suggest that this or any other metaphysical system has any claims whatever to finality.

Meanwhile we are in for a few centuries during which many practical activities will probably be conducted on a basis, not of materialism, but of Kantian idealism. How will this affect our manners, morals and politics? Frankly I do not know, though I think the effect will be as great as that of Newton's work, which created most of the intellectual forces of the 18th

century. The Condorcets, Benthams, and Marxs of the future will I think be as ruthlessly critical of the metaphysics and ethics of their times as were their predecessors, but not quite so sure of their own; they will lack a certain heaviness of touch which we may note in Utilitarianism and Socialism. They will recognise that perhaps in ethics as in physics, there are so to speak fourth and fifth dimensions that show themselves by effects which, like the perturbations of the planet Mercury, are hard to detect even in one generation, but yet perhaps in the course of ages are quite as important as the three-dimensional phenomena.

If the quantum hypothesis is generally adopted even more radical alterations in our thinking will be necessary.

But I feel it premature even to suggest their direction in the present unsatisfactory state of quantum mechanics. It may be that as Poincare (the other Poincare) suggested we shall be forced to conceive of all change as occurring in a series of clicks, and all space as consisting of discrete points. However this may be it is safe to say that a better knowledge of the properties of radiation will permit us to produce it in a more satisfactory manner than is at present possible. Almost all our present sources of light are hot bodies, 95% of whose radiation is invisible. To light a lamp as a source of light is about as wasteful of energy as to burn down one's house to roast one's pork. It is a fairly safe prophecy that in 50 years light will cost about

a fiftieth of its present price, and there will be no more night in our cities. The alternation of day and night is a check on the freedom of human activity which must go the way of other spatial and temporal checks. In the long run I think that all that applied physics can do for us is to abolish these checks. It enables us to possess more, travel more, and communicate more. I shall not attempt to predict in detail the future developments of transport and communication. They are only limited by the velocity of light. We are working towards a condition when any two persons on earth will be able to be completely present to one another in not more than 1-24 of a second. We shall never reach it, but that is the limit which we shall approach indefinitely.

Developments in this direction are tending to bring mankind more and more together, to render life more and more complex, artificial, and rich in possibilities—to increase indefinitely man's powers for good and evil.

But there are two prerequisites for all progress of this kind, namely continuous supplies of human and mechanical power. As industries become more and more closely interwoven, so that a dislocation of any one will paralyse a dozen others (and that is the position towards which we are rapidly moving), the ideal of the leaders of industry, under no matter what economic system, will be directed less and less to the indefinite increase of production in the intervals between such dislocations, and more and more

to stable and regular production, even at the cost of reduction of profits and output while the industry is proceeding normally. It is quite possible that capitalism itself may demand that the control of certain key industries be handed over completely to the workers in those industries, simply in order to reduce the number of sporadic strikes in them. And as industrial progress continues an ever larger number—perhaps the majority—of industries will become key industries. The solution may be entirely different — we may well see a return to feudalism. But the probability is that the problem will be solved. This view may seem optimistic, but it is more likely than the alternative thesis which may be briefly stated as follows: "*No human society*

will ever succeed in producing a stable organization in which the majority of the population is employed otherwise than in agriculture, animal-rearing, hunting or fishing." It took some thousands of years to produce the stable agricultural society which forms the basis of European life and whose morals we are too apt to regard as eternal truths. It should take a shorter time to evolve a stable industrial society. The people that do so will inherit the earth. In sum, I believe that the progress of science will ultimately make industrial injustice as self-destructive as it is now making international injustice.

As for the supplies of mechnical power, it is axiomatic that the exhaustion of our coal and oil-fields is a matter of centuries only. As it has

often been assumed that their exhaustion would lead to the collapse of industrial civilization, I may perhaps be pardoned if I give some of the reasons which lead me to doubt this proposition.

Water-power is not, I think, a probable substitute, on account of its small quantity, seasonal fluctuation, and sporadic distribution. It may perhaps, however, shift the centre of industrial gravity to well-watered mountainous tracts such as the Himalayan foothills, British Columbia, and Armenia. Ultimately we shall have to tap those intermittent but inexhaustible sources of power, the wind and the sunlight. The problem is simply one of storing their energy in a form as convenient as coal or petrol. If a

windmill in one's back garden could produce a hundredweight of coal daily (and it can produce its equivalent in energy), our coalmines would shut down to-morrow. Even to-morrow a cheap, foolproof, and durable storage battery may be invented, which will enable us to transform the intermittent energy of the wind into continuous electric power.

Personally, I think that four hundred years hence the power question in England may be solved somewhat as follows: The country will be covered with rows of metallic windmills working electric motors which in their turn supply current at a very high voltage to great electric mains. At suitable distances, there will be great power stations where during windy weather

the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen. These gases will be liquefied, and stored in vats vacuum jacketed reservoirs, probably sunk in the ground. If these reservoirs are sufficiently large, the loss of liquid due to leakage inwards of heat will not be great; thus the proportion evaporating daily from a reservoir 100 yards square by 60 feet deep would not be 1-1000 of that lost from a tank measuring two feet each way. In times of calm, the gases will be recombined in explosion motors working dynamos which produce electrical energy once more, or more probably in oxidation cells. Liquid hydrogen is weight for weight the most efficient known method of storing energy, as it gives about

three times as much heat per pound as petrol. On the other hand it is very light, and bulk for bulk has only one-third of the efficiency of petrol. This will not, however, detract from its use in aeroplanes, where weight is more important than bulk. These huge reservoirs of liquefied gases will enable wind energy to be stored, so that it can be expended for industry, transportation, heating, and lighting, as desired. The initial costs will be very considerable, but the running expenses less than those of our present system. Among its more obvious advantages will be the fact that energy will be as cheap in one part of the country as another, so that industry will be greatly decentralized; and that no smoke or ash will be produced.

It is on some such lines as these, I think, that the problem will be solved. It is essentially a practical problem, and the exhaustion of our coalfields will furnish the necessary stimulus for its solution. Even now perhaps Italy might achieve economic independence by the expenditure of a few million pounds upon research on the lines indicated. I may add in parenthesis that, on thermodynamical grounds which I can hardly summarize shortly, I do not much believe in the commercial possibility of induced radio-activity.

Before I turn to the principal part of my subject I should like to consider very briefly the influence on art and literature of our gradual conquest of space and time. I think that the blame for the decay of certain arts

rests primarily on the defective education of the artists. An artist must understand his subject matter. At present not a single competent poet and very few painters and etchers outside the Glasgow School understand industrial life, and I believe that there is only one architect of any real originality who understands the possibilities of ferro-concrete. I do not know his name, but he produced in Soissons before the war a market-place with the dignity and daring of an ancient Egyptian temple. If I knew that he had been entrusted with the rebuilding of Soissons, I could not regret its destruction.

Now if we want poets to interpret physical science as Milton and Shelley did (Shelley and Keats were the last

English poets who were at all up-to-date in their chemical knowledge), we must see that our possible poets are instructed, as their masters were, in science and economics. I am absolutely convinced that science is vastly more stimulating to the imagination than are the classics, but the products of this stimulus do not normally see the light because scientific men as a class are devoid of any perception of literary form. When they can express themselves we get a Butler or a Norman Douglas. Not until our poets are once more drawn from the educated classes (I speak as a scientist), will they appeal to the average man by showing him the beauty in his own life as Homer and Virgil appealed to the street urchins who scrawled their verses on the walls of Pompeii.

And if we must educate our poets and artists in science, we must educate our masters, labour and capital, in art. Personally I believe that we may have good hopes of both. The capitalist's idea of art in industry at present tends to limit itself to painting green and white stripes on the front of his factories in certain cases. This is a primitive type of decoration, but it has, I think, the root of the matter in it. Before long someone may discover that frescoes inside a factory increase the average efficiency of the worker 1.03% and art will become a commercial proposition once more. Even now it is being discovered that artistic advertising often pays. Similarly I do not doubt that labour will come to find that it cannot live by bread (or shall we say

bread and beer) alone. But it can hardly be expected to make this discovery until it is assured of its supply of bread and beer.

Applied chemistry has introduced into human life no radical novelty of the importance of the heat-engine or the telegraph. It has vastly increased the production of various types of substance the most important being metals. But there were explosives, dyes, and drugs before chemistry was a science, and its progress along present lines will mainly alter life in a quantitative manner. Perhaps the biggest problems before it in metallurgy are the utilization of low-grade iron ores, and the production of aluminium from clay, which contains up to 24% of that metal. I do not think that even when this is accomplished

aluminium will oust iron and steel as they ousted bronze and flint, but it and its alloys will certainly take the second, and possibly the first place as industrial metals. There is just a hope, though I fear little more, that a large-scale production of perfume may form the basis of a re-education of our rather rudimentary sense of smell, but the most interesting possibilities of chemical invention are very clearly in biological chemistry, and for the following reasons.

Desirable substances fall on the whole into two classes. The first are desirable on account of their physical or chemical properties, for example iron, wood or glass, which we use as a part of systems such as fires, houses, or razors, which procure us certain benefits. The second are desirable on account

of their physiological properties. Such substances include foods, drinks, tobacco, and drugs. Colours and scents occupy an intermediate position. The value of this second class of substances rests on a quite special relationship to the human organism which depends in the most intimate way on the constitution of the latter, and has not in general been at all fully explained in terms of physics and chemistry. For example fires can be made of coal or peat instead of wood, but no other chemical substance has the same effect as water or alcohol. So unless a chemical substance has new physiological properties its production will merely serve to improve or make possible some appliance whose use lies within the sphere of applied physics.

Within historical time two and only two substances of the second class have come into universal use in Europe, namely caffeine and nicotine, which were introduced into this country in the sixteenth and seventeenth centuries. There are others of immense importance, such as chloroform and quinine, but their use is not universal. But coffee, tea, and tobacco, with alcohol, are as much a part of normal life as food and water. There is no reason to suppose that the list of such substances is exhausted. During the war Embden* the professor of physiology in Frankfurt University discovered that a dose of about 7 grams of acid sodium phosphate increases a man's capacity

* Embden, Grafe, and Schmitz. *Zeitschrift für physiologische Chemie,* Vol. 113, p. 67, 1921.

for prolonged muscular work by about 20%, and probably aids in prolonged mental work. It can be taken over very lengthy periods. A group of coal-miners took it for nine months on end with very great effect on their output. It has no after-effects like those of alcohol, and one cannot take a serious overdose as it merely acts as a purgative. (They gave certain Stosstruppen too much!) Thousands of people in Germany take it habitually. It is possible that it may become as normal a beverage as coffee or tea. It costs 1/9 per pound, or ⅓d. per dose.

The vast majority of chemical substances with physiological properties are unsuited for daily use like castor oil, or dangerous like morphine; probably none are without bad effects in

certain cases. Those which are susceptible of daily use are of the utmost social importance. Tobacco has slight but definite effects on the character. Coffee-houses in London in the seventeenth and eighteenth centuries and cafes in modern Europe were and are civilizing influences of incalculable value. But these substances are profoundly obnoxious to a certain type of mind. It would perhaps be fantastic to suggest that Sir Walter Raleigh owed his death in part to his sovereign's objection to tobacco. But if he is not its protomartyr it is at least probable that more men have died for tobacco smoking at the hands of Sikhs, Senussis, and Wahabis, whose religions forbid this practice, than died under the Roman empire for professing Christianity.

Should it ever be generally realised that temperance is a mean we may expect that mankind will ultimately have at its disposal a vast array of substances like wine, coffee, and tobacco, whose intelligent use can add to the amenity of life and promote the expression of man's higher faculties.

But before that day comes chemistry will be applied to the production of a still more important group of physiologically active substances, namely foods. The facts about food are rather curious. Everyone knows that food is ultimately produced by plants, though we may get it at second or third hand if we eat animals or their products. But the average plant turns most of its sugar not into starch which is digestible, but into cellulose which is not, but forms

its woody skeleton. The hoofed animals have dealt with this problem in their own way, by turning their bellies into vast hives of bacteria that attack cellulose, and on whose by-products they live. We have got to do the same, but outside our bodies. It may be done on chemical lines. Irvine has obtained a 95% yield of sugar from cellulose, but at a prohibitive cost. Or we may use micro-organisms, but in any case within the next century sugar and starch will be about as cheap as sawdust. Many of our foodstuffs, including the proteins, we shall probably build up from simpler sources such as coal and atmospheric nitrogen. I should be inclined to allow 120 years, but not much more, before a completely satisfactory diet can be produced in this way on a commercial scale.

This will mean that agriculture will become a luxury, and that mankind will be completely urbanized. Personally I do not regret the probable disappearance of the agricultural labourer in favour of the factory worker, who seems to me a higher type of person from most points of view. Human progress in historical time has been the progress of cities dragging a reluctant countryside in their wake. Synthetic food will substitute the flower garden and the factory for the dunghill and the slaughterhouse, and make the city at last self-sufficient.

There's many a strong farmer whose heart would break in two
If he could see the townland that we are riding to.
Boughs have their fruit and blossom at all times of the year,
Rivers are running over with red beer and brown beer,

An old man plays the bagpipes in a golden and silver wood,
Queens, their eyes blue like the ice, are dancing in a crowd.

I should have liked had time allowed to have added my quota to the speculations which have been made with regard to inter-planetary communication. Whether this is possible I can form no conjecture; that it will be attempted I have no doubt whatever.

With regard to the application of biology to human life, the average prophet appears to content himself with considerable if rather rudimentary progress in medicine and surgery, some improvements in domestic plants and animals, and possibly the introduction of a little eugenics. The eugenic official, a compound, it would appear, of the

policeman, the priest and the procurer, is to hale us off at suitable intervals to the local temple of Venus Genetrix with a partner chosen, one gathers, by something of the nature of a glorified medical board. To this prophecy I should reply that it proceeds from a type of mind as lacking in originality as in knowledge of human nature. Marriage "by numbers", so to speak, was a comparatively novel idea when proposed by Plato 2,300 years ago, but it has already actually been practised in various places, notably among the subjects of the Jesuits in Paraguay. It is moreover likely, as we shall see, that the ends proposed by the eugenist will be attained in a very different manner.

But before we proceed to prophecy

I should like to turn back to the past and examine very briefly the half dozen or so important biological inventions which have already been made. By a biological invention I mean the establishment of a new relationship between man and other animals or plants, or between different human beings, provided that such relationship is one which comes primarily under the domain of biology rather than physics, psychology or ethics. Of the biological inventions of the past, four were made before the dawn of history. I refer to the domestication of animals, the domestication of plants, the domestication of fungi for the production of alcohol, and to a fourth invention, which I believe was of more ultimate and far-reaching importance than any

of these, since it altered the path of sexual selection, focussed the attention of man as a lover upon woman's face and breasts, and changed our idea of beauty from the steatapygous Hottentot to the modern European, from the Venus of Brassempouy to the Venus of Milo. There are certain races which have not yet made this last invention. And in our own day two more have been made, namely bactericide and the artificial control of conception.

The first point that we may notice about these inventions is that they have all had a profound emotional and ethical effect. Of the four earlier there is not one which has not formed the basis of a religion. I do not know what strange god will have the hardihood to adopt Charles Bradlaugh and

Annie Besant in the place of Triptolemus and Noah, but one may remark that it is impossible to keep religion out of any discussion of the practices which they popularized.

The second point is perhaps harder to express. The chemical or physical inventor is always a Prometheus. There is no great invention, from fire to flying, which has not been hailed as an insult to some god. But if every physical and chemical invention is a blasphemy, every biological invention is a perversion. There is hardly one which, on first being brought to the notice of an observer from any nation which had not previously heard of their existence, would not appear to him as indecent and unnatural.

Consider so simple and time-honoured

a process as the milking of a cow. The milk which should have been an intimate and almost sacramental bond between mother and child is elicited by the deft fingers of a milk-maid, and drunk, cooked, or even allowed to rot into cheese. We have only to imagine ourselves as drinking any of its other secretions, in order to realise the radical indecency of our relation to the cow.*

No less disgusting a priori is the

* The Hindus have recognized the special and physiological relation of man to the cow by making the latter animal holy. A good Hindu would no more kill a cow than his foster-mother. But the holiness of the cow has unfortunately extended to all its products, and the extensive use of cowdung in Indian religious ceremonies is disgusting to the average European. The latter however, is insensitive to the equally loathsome injunctions of the Catholic Church with regard to human marriage. It would perhaps be better if both marriage and milking could be secularized.

process of corruption which yields our wine and beer. But in actual fact the processes of milking and of the making and drinking beer appear to us profoundly natural; they have even tended to develop a ritual of their own whose infraction nowadays has a certain air of impropriety. There is something slightly disgusting in the idea of milking a cow electrically or drinking beer out of tea-cups. And all this of course applies much more strongly to the sexual act.

I fancy that the sentimental interest attaching to Prometheus has unduly distracted our attention from the far more interesting figure of Daedalus. It is with infinite relief that amidst a welter of heroes armed with gorgon's heads or protected by Stygian baptisms

the student of Greek mythology comes across the first modern man. Beginning as a realistic sculptor (he was the first to produce statues whose feet were separated) it was natural that he should proceed to the construction of an image of Aphrodite whose limbs were activated by quicksilver. After this his interest inevitably turned to biological problems, and it is safe to say that posterity has never equalled his only recorded success in experimental genetics. Had the housing and feeding of the Minotaur been less expensive it is probable that Daedalus would have anticipated Mendel. But Minos held that a labyrinth and an annual provision of 50 youths and 50 virgins were excessive as an endowment for research, and in order to escape from his

ruthless economies Daedalus was forced to invent the art of flying. Minos pursued him to Sicily and was slain there. Save for his valuable invention of glue, little else is known of Daedalus. But it is most significant that, although he was responsible for the death of Zeus' son Minos he was neither smitten by a thunderbolt, chained to a rock, nor pursued by furies. Still less did any of the rather numerous visitors to Hades discover him either in Elysium or Tartarus. We can hardly imagine him as a member of the throng of shades who besieged Charon's ferry like sheep at a gap. He was the first to demonstrate that the scientific worker is not concerned with gods.

The unconscious mind of the early Greeks, who focussed in this amazing

figure the dim traditions of Minoan science, was presumably aware of this fact. The most monstrous and unnatural action in all human legend was unpunished in this world or the next. Even the death of Icarus must have weighed lightly with a man who had already been banished from Athens for the murder of his nephew. But if he escaped the vengeance of the gods he has been exposed to the universal and agelong reprobation of a humanity to whom biological inventions are abhorrent, with one very significant exception. Socrates was proud to claim him as an ancestor.

The biological invention then tends to begin as a perversion and end as a ritual supported by unquestioned beliefs and prejudices. Even now surgical

cleanliness is developing its rites and its dogmas, which, it may be remarked, are accepted most religiously by women. With the above facts in your minds I would ask you to excuse what at first sight might appear improbable or indecent in any speculations which appear below, and to dismiss from your minds the belief that biology will consist merely in physical and chemical discoveries as applied to men, animals and plants.

I say advisedly "will consist", for we are at present almost completely ignorant of biology, a fact which often escapes the notice of biologists, and renders them too presumptuous in their estimates of the present position of their science, too modest in their claims for its future. If for example

we take a typical case of applied biology such as the detection and destruction of the cholera bacillus, we find a great deal of science involved, but the only purely biological principle is the very important but not very profound one that some bacteria kill some men. The really scientific parts of the process are the optical and chemical methods involved in the magnification, staining and killing of the bacilli. When on the other hand we come to immunization to typhoid we find certain purely biological principles involved which are neither simple nor at all completely understood.

Actually biological theory consists of some ancient but not very easily stated truths about organisms in general, due largely to Aristotle, Hippocrates and Harvey, a few great principles

such as those formulated by Darwin, Mayer, Claude Bernard, and Mendel, and a vast mass of facts about individual organisms and their parts which are still awaiting adequate generalization.

Darwin's results are beginning to be appreciated, with alarming effects on certain types of religion, those of Weismann and Mendel will be digested in the course of the present century, and are going to affect political and philosophical theories almost equally profoundly. I need hardly say that these latter results deal with the question of reproduction and heredity. We may expect, moreover, as time goes on, that a series of shocks of the type of Darwinism will be given to established opinions on all sorts of subjects. One

cannot suggest in detail what these shocks will be, but since the opinions on which they will impinge are deep-seated and irrational, they will come upon us and our descendants with the same air of presumption and indecency with which the view that we are descended from monkeys came to our grandfathers. But owing to man's fortunate capacity for thinking in watertight (or rather idea-tight) compartments, they will probably not have immediate and disruptive effects upon society any more than Darwinism had.

Far more profound will be the effect of the practical applications of biology. I believe that the progress of medicine has had almost, if not quite, as deep an effect on society in Western Europe

as the industrial revolution. Apart from the important social consequences which have flowed from the partial substitution of the doctor for the priest, its net result has been that whereas four hundred years ago most people died in childhood, they now live on an average, (apart from the late war), until forty-five. Bad as our urban conditions often are, there is not a slum in the country which has a third of the infantile death-rate of the royal family in the middle ages. Largely as a result of this religion has come to lay less and less stress on a good death, and more and more on a good life, and its whole outlook has gradually changed in consequence. Death has receded so far into the background of our normal thoughts that

when we came into somewhat close contact with it during the war most of us failed completely to take it seriously.

Similarly institutions which were based on short lives have almost wholly collapsed. For example the English land system postulated that the land-owner should die aged about forty, and be succeeded by his eldest son, aged about twenty. The son had spent most of his life on the estate, and had few interests outside it. He managed it at least as well as anyone else could have done. Nowadays the father dodders on till about eighty, and is generally incompetent for ten years before his death. His son succeeds him at the age of fifty or so, by which time he may be a fairly competent

colonel or stockbroker, but cannot hope to learn the art of managing an estate. In consequence he either hands it over to an agent who is deprived of initiative and often corrupt, or runs it unscientifically, gets a low return, and ascribes to Bolshevism what he should really lay at the door of vaccination.

But to return, if I may use the expression, to the future, I am going to suggest a few obvious developments which seem probable in the present state of biological science, without assuming any great new generalizations of the type of Darwinism. I have the very best precedents for introducing a myth at this point, so perhaps I may be excused if I reproduce some extracts from an essay on the influence of biology on history during the 20th

century which will (it is hoped) be read by a rather stupid undergraduate member of this university to his supervisor during his first term 150 years hence.

"As early as the first decade of the twentieth century we find a conscious attempt at the application of biology to politics in the so-called eugenic movement. A number of earnest persons, having discovered the existence of biology, attempted to apply it in its then very crude condition to the production of a race of super-men, and in certain countries managed to carry a good deal of legislation. They appear to have managed to prevent the transmission of a good deal of syphilis, insanity, and the like, and they certainly succeeded in producing

the most violent opposition and hatred amongst the classes whom they somewhat gratuitously regarded as undesirable parents. (There was even a rebellion in Nebraska). However, they undoubtedly prepared public opinion for what was to come, and so far served a useful purpose. Far more important was the progress in medicine which practically abolished infectious diseases in those countries which were prepared to tolerate the requisite amount of state interference in private life, and finally, after the league's ordinance of 1958, all over the world; though owing to Hindu opposition, parts of India were still quite unhealthy up to 1980 or so.

But from a wider point of view the most important biological work in the

first third of the century was in experimental zoology and botany. When we consider that in 1912 Morgan had located several Mendelian factors in the nucleus of Drosophila, and modified its sex-ratio, while Marmorek had taught a harmless bacillus to kill guinea-pigs, and finally in 1913 Brachet had grown rabbit embryos in serum for some days, it is remarkable how little the scientific workers of that time, and a fortiori the general public, seem to have foreseen the practical bearing of such results.

As a matter of fact it was not until 1940 that Selkovski invented the purple alga *Porphyrococcus fixator* which was to have so great an effect on the world's history. In the 50 years before this date the world's average wheat

yield per hectar had been approximately doubled, partly by the application of various chemical manures, but most of all by the results of systematic crossing work with different races; there was however little prospect of further advance on any of these lines. *Porphyrococcus* is an enormously efficient nitrogen-fixer and will grow in almost any climate where there are water and traces of potash and phosphates in the soil, obtaining its nitrogen from the air. It has about the effect in four days that a crop of vetches would have had in a year. It could not, of course have been produced in the course of nature, as its immediate ancestors would only grow in artificial media and could not have survived outside a laboratory. Wherever nitrogen was

the principal limiting factor to plant growth it doubled the yield of wheat, and quadrupled the value of grass land for grazing purposes. The enormous fall in food prices and the ruin of purely agricultural states was of course one of the chief causes of the disastrous events of 1943 and 1944. The food glut was also greatly accentuated when in 1942 the Q strain of *Porphyrococcus* escaped into the sea and multiplied with enormous rapidity. Indeed for two months the surface of the tropical Atlantic set to a jelly, with disastrous results to the weather of Europe. When certain of the plankton organisms developed ferments capable of digesting it the increase of the fish population of the seas was so great as to make fish the universal good that it is now, and

to render even England self-supporting in respect of food. So great was the prosperity in England that in that year the coal-miner's union entered its first horse for the Derby (a horse-race which still took place annually at that time).

It was of course as the result of its invasion by *Porphyrococcus* that the sea assumed the intense purple colour which seems so natural to us, but which so distressed the more aesthetically minded of our great grand-parents who witnessed the change. It is certainly curious to us to read of the sea as having been green or blue. I need not detail the work of Ferguson and Rahmatullah who in 1957 produced the lichen which has bound the drifting sand of the world's deserts (for it was merely a

continuation of that of Selkovski), nor yet the story of how the agricultural countries dealt with their unemployment by huge socialistic windpower schemes.

It was in 1951 that Dupont and Schwarz produced the first ectogenetic child. As early as 1901 Heape had transferred embryo rabbits from one female to another, in 1925 Haldane had grown embryonic rats in serum for ten days, but had failed to carry the process to its conclusion, and it was not till 1940 that Clark succeeded with the pig, using Kehlmann's solution as medium. Dupont and Schwarz obtained a fresh ovary from a woman who was the victim of an aeroplane accident, and kept it living in their medium for five years. They obtained several eggs

from it and fertilized them successfully, but the problem of the nutrition and support of the embryo was more difficult, and was only solved in the fourth year. Now that the technique is fully developed, we can take an ovary from a woman, and keep it growing in a suitable fluid for as long as twenty years, producing a fresh ovum each month, of which 90 per cent can be fertilized, and the embryos grown successfully for nine months, and then brought out into the air. Schwarz never got such good results, but the news of his first success caused an unprecedented sensation throughout the entire world, for the birthrate was already less than the deathrate in most civilised countries. France was the first country to adopt ectogenesis

officially, and by 1968 was producing 60,000 children annually by this method. In most countries the opposition was far stronger, and was intensified by the Papal Bull "Nunquam prius audito", and the similar fetwa of the Khalif, both of which appeared in 1960.

As we know ectogenesis is now universal, and in this country less than 30 per cent of children are now born of woman. The effect on human psychology and social life of the separation of sexual love and reproduction which was begun in the 19th century and completed in the 20th is by no means wholly satisfactory. The old family life had certainly a good deal to commend it, and although nowadays we bring on lactation in women by injection

of placentin as a routine, and thus conserve much of what was best in the former instinctive cycle, we must admit that in certain respects our great grandparents had the advantage of us. On the other hand it is generally admitted that the effects of selection have more than counterbalanced these evils. The small proportion of men and women who are selected as ancestors for the next generation are so undoubtedly superior to the average that the advance in each generation in any single respect, from the increased output of first-class music to the decreased convictions for theft, is very startling. Had it not been for ectogenesis there can be little doubt that civilization would have collapsed within a measurable time owing to the greater

fertility of the less desirable members of the population in almost all countries.

It is perhaps fortunate that the process of becoming an ectogenetic mother of the next generation involves an operation which is somewhat unpleasant, though now no longer disfiguring or dangerous, and never physiologically injurious, and is therefore an honour but by no means a pleasure. Had this not been the case, it is perfectly possible that popular opposition would have proved too strong for the selectionist movement. As it was the opposition was very fierce, and characteristically enough this country only adopted its present rather stringent standard of selection a generation later than Germany, thought it is now perhaps more advanced

than any other country in this respect. The advantages of thorough-going selection, have, however, proved to be enormous. The question of the ideal sex ratio is still a matter of violent discussion, but the modern reaction towards equality is certainly strong."

Our essayist would then perhaps go on to discuss some far more radical advances made about 1990, but I have only quoted his account of the earlier applications of biology. The second appears to me to be neither impossible nor improbable, but it has those features which we saw above to be characteristic of biological inventions. If reproduction is once completely separated from sexual love mankind will be free in an altogether new sense. At present the national character is

changing slowly according to quite unknown laws. The problem of politics is to find institutions suitable to it. In the future perhaps it may be possible by selective breeding to change character as quickly as institutions. I can foresee the election placards of 300 years hence, if such quaint political methods survive, which is perhaps improbable, "Vote for Smith and more musicians", "Vote for O'Leary and more girls", or perhaps finally "Vote for Macpherson and a prehensile tail for your great-grandchildren". We can already alter animal species to an enormous extent, and it seems only a question of time before we shall be able to apply the same principles to our own.

I suggest then that biology will

probably be applied on lines roughly resembling the above. There are perhaps equally great possibilities in the way of the direct improvement of the individual, as we come to know more of the physiological obstacles to the development of different faculties. But at present we can only guess at the nature of these obstacles, and the line of attack suggested in the myth is the one which seems most obvious to a Darwinian. We already know however that many of our spiritual faculties can only be manifested if certain glands, notably the thyroid and sex-glands, are functioning properly, and that very minute changes in such glands affect the character greatly. As our knowledge of this subject increases we may be able, for example,

to control our passions by some more direct method than fasting and flagellation, to stimulate our imagination by some reagent with less after-effects than alcohol, to deal with perverted instincts by physiology rather than prison. Conversely there will inevitably arise possibilities of new vices similar to but even more profound than those opened up by the pharmacological discoveries of the 19th century.

The recent history of medicine is as follows. Until about 1870 medicine was largely founded on physiology, or, as the Scotch called it "Institutes of medicine". Disease was looked at from the point of view of the patient, as injuries still are. Pasteur's discovery of the nature of infectious disease transformed the whole outlook,

and made it possible to abolish one group of diseases. But it also diverted scientific medicine from its former path, and it is probable that, were bacteria unknown, though many more people would die of sepsis and typhoid, we should be better able to cope with kidney disease and cancer. Certain diseases such as cancer are probably not due to specific organisms, whilst others such as phthisis are due to forms which are fairly harmless to the average person, but attack others for unknown reasons. We are not likely to deal with them effectually on Pasteur's lines, we must divert our view from the micro-organism to the patient. Where the doctor cannot deal with the former he can often keep the patient alive long enough to be able to do so

himself. And here he has to rely largely on a knowledge of physiology. I do not say that a physiologist will discover how to prevent cancer. Pasteur started life as a crystallographer. But whoever does so is likely at least to make use of physiological data on a large scale.

The abolition of disease will make death a physiological event like sleep. A generation that has lived together will die together. I suspect that man's desire for a future life is largely due to two causes, a feeling that most lives are incomplete, and a desire to meet friends from whom we have parted prematurely. A gentle decline into the grave at the end of a completed life's work will largely do away with the first, and our contemporaries will

rarely leave us sorrowing for long.

Old age is perhaps harder on women than on men. They live longer, but their life is too often marred by the sudden change which generally overtakes them between forty and fifty, and sometimes leaves them a prey to disease, though it may improve their health. This change seems to be due to a sudden failure of a definite chemical substance produced by the ovary. When we can isolate and synthesize this body we shall be able to prolong a woman's youth, and allow her to age as gradually as the average man.

Psychology is hardly a science yet. Like biology it has arrived at certain generalizations of a rather abstract and philosophic character, but these are still to some extent matters of

controversy. And though a vast number of most important empirical facts are known, only a few great generalizations from them—such as the existence of the subconscious mind—have yet been made. But anyone who has seen even a single example of the power of hypnotism and suggestion must realise that the face of the world and the possibilities of existence will be totally altered when we can control their effects and standardize their application, as has been possible, for example, with drugs which were once regarded as equally magical. Infinitely greater, of course, would be the results of the opening up of systematic communication with spiritual beings in another world, which is claimed as a scientific possibility. Spiritualism is

already Christianity's most formidable enemy, and we have no data which allows us to estimate the probable effect on man of a religion whose dogmas are a matter of experiment, whose mysteries are prosaic as electric lighting, whose ethics are based on the observed results in the next world of a good or bad life in this. Yet that is the prospect before us if spiritualism obtains the scientific verification which it is now demanding, not perhaps with great success.

I have only been able, in the time at my disposal, to traverse a very few of the possible fields of scientific advance. If I have convinced anyone present that science has still a good deal up her sleeve, and that of a sufficiently startling character, I shall be amply

repaid. If anything I have said appears to be of a gratuitously disgusting nature, I would reply that certain phenomena of normal life do seem to many to be of that nature, and that these phenomena are of the utmost scientific and practical importance.

I have tried to show why I believe that the biologist is the most romantic figure on earth at the present day. At first sight he seems to be just a poor little scrubby underpaid man, groping blindly amid the mazes of the ultra-microscopic, engaging in bitter and lifelong quarrels over the nephridia of flatworms, waking perhaps one morning to find that someone whose name he has never heard has demolished by a few crucial experiments the work which he had hoped would render him immortal.

There is real tragedy in his life, but he knows that he has a responsibility which he dare not disclaim, and he is urged on, apart from all utilitarian considerations, by something or someone which he feels to be higher than himself.

The conservative has but little to fear from the man whose reason is the servant of his passions, but let him beware of him in whom reason has become the greatest and most terrible of the passions. These are the wreckers of outworn empires and civilisations, doubters, disintegrators, deicides. In the past they have been, in general, men like Voltaire, Bentham, Thales, Marx, and very possibly the divine Julius, but I think that Darwin furnishes an example of the same

relentlessness of reason in the field of science. I suspect that as it becomes clear that at present reason not only has a freer play in science than elsewhere, but can produce as great effects on the world through science as through politics, philosophy, or literature, there will be more Darwins. Such men are interested primarily in truth as such, but they can hardly be quite uninterested in what will happen when they throw down their dragon's teeth into the world.

I do not say that biologists as a general rule try to imagine in any detail the future applications of their science. The central problems of life for them may be the relationship between the echinoderms and brachiopods, and the attempt to live on their

salaries. They do not see themselves as sinister and revolutionary figures. They have no time to dream. But I suspect that more of them dream than would care to confess it.

I have given above a very small selection from my dreams. Perhaps they are bad dreams. It is of course almost hopeless to attempt any very exact prophecies as to how in detail scientific knowledge is going to revolutionize human life, but I believe that it will continue to do so, and even more profoundly than I have suggested. And though personally I am Victorian enough in my sympathies to hope that after all family life, for example, may be spared, I can only reiterate that not one of the practical advances which I have predicted is not already fore-

shadowed by recent scientific work. If a chemist or physicist living at the end of the seventeenth century had been asked to predict the future application of his science he would doubtless have made many laughable errors in the best Laputan style, but he would have been certain that it would somehow be applied, and his faith would have been justified.

We must regard science then from three points of view. First it is the free activity of man's divine faculties of reason and imagination. Secondly it is the answer of the few to the demands of the many for wealth, comfort and victory, for "νόσων τ' ἀπείρους καὶ μακραίωνας βίους," gifts which it will grant only in exchange for peace, security and stagnation. Finally it is

man's gradual conquest, first of space and time, then of matter as such, then of his own body and those of other living beings, and finally the subjugation of the dark and evil elements in his own soul.

None of these conquests will ever be complete, but all, I believe will be progressive. The question of what he will do with these powers is essentially a question for religion and aesthetic. It may be urged that they are only fit to be placed in the hands of a being who has learned to control himself, and that man armed with science is like a baby with a box of matches.

The answer to this contention may, I think, be found in the daily papers. For scores of centuries idealists had urged that wars must cease and all

the earth be united under one rule. As long as any other alternative was possible it was persisted in. The events of the last nine years constituted a reductio ad absurdum of war, but when we ask who was responsible for this we shall find that it was not the visionaries but men like Black, Kekule, and Langley, who enlarged man's power over nature until he was forced by the inexorable logic of facts to form the nucleus of an international government.

We have already reacted against the frame of mind that engendered the league of nations, but we have not reacted at all completely. The league exists and is working, and in every country on earth there are many people, and ordinary normal people,

who favour the idea in one form or another of a world state. I do not suggest that a world-state will arise from the present league—or for the matter of that from the third international. I merely observe that there is a widespread and organized desire for such an institution, and several possible nuclei for it. It may take another world-war or two to convert the majority. The prospect of the next world-war has at least this satisfactory element. In the late war the most rabid nationalists were to be found well behind the front line. In the next war no one will be behind the front line. It will be brought home to all whom it may concern that war is a very dirty business.

No doubt there is a fair chance that

the possibility of human organization on a planetary scale may be rendered impossible by such a war. If so mankind will probably have to wait for a couple of thousand years for another opportunity. But to the student of geology such a period is negligible. It took man 250,000 years to transcend the hunting pack. It will not take him so long to transcend the nation.

I think then that the tendency of applied science is to magnify injustices until they become too intolerable to be borne, and the average man whom all the prophets and poets could not move, turns at last and extinguishes the evil at its source. Marx' theory of industrial evolution is a particular example of this tendency, though it does not in the least follow that his

somewhat artificial solution of the problem will be adopted.

It is probable that biological progress will prove to be as incompatible with certain of our social evils as industrial progress has proved to be with war or certain systems of private ownership. To take a concrete example it is clear that the second biological invention considered by my future essayist would be intolerable in conjunction with our present system of relations between classes and sexes. Moral progress is so difficult that I think any developments are to be welcomed which present it as the naked alternative to destruction, no matter how horrible may be the stimulus which is necessary before man will take the moral step in question.

To sum up then, science is as yet in its infancy, and we can foretell little of the future save that the thing that has not been is the thing that shall be; that no beliefs, no values, no institutions are safe. So far from being an isolated phenomenon the late war is only an example of the disruptive results that we may constantly expect from the progress of science. The future will be no primrose path. It will have its own problems. Some will be the secular problems of the past, giant flowers of evil blossoming at last to their own destruction. Others will be wholly new. Whether in the end man will survive his accessions of power we cannot tell. But the problem is no new one. It is the old paradox of freedom re-enacted with mankind

for actor and the earth for stage. To those who believe in the divinity of that part of man which aspires after knowledge for its own sake, who are able, in the words of Boethius:

"te cernere finis
"Principium, vector, dux, semita, terminus idem".

the prospect will appear most hopeful. But it is only hopeful if mankind can adjust its morality to its powers. If we can succeed in this, then science holds in her hands one at least of the keys to the thorny and arduous path of moral progress, then:

"Per cruciamina leti
"Via panditur ardua justis,
"Et ad astra doloribus itur".

That is possibly a correct large-scale

view, but it is only for short periods that one can take views of history sufficiently broad to render the fate of one's own generation irrelevant. The scientific worker is brought up with the moral values of his neighbours. He is perhaps fortunate if he does not realize that it is his destiny to turn good into evil. The moral and physical (though not the intellectual) virtues are means between two extremes. They are essentially quantitative. It follows that an alteration in the scale of human power will render actions bad which were formerly good. Our increased knowledge of hygiene has transformed resignation and inaction in face of epidemic disease from a religious virtue to a justly punishable offence. We have improved our armaments, and

patriotism, which was once a flame upon the altar, has become a world-devouring conflagration.

The time has gone by when a Huxley could believe that while science might indeed remould traditional mythology, traditional morals were impregnable and sacrosanct to it. We must learn not to take traditional morals too seriously. And it is just because even the least dogmatic of religions tends to associate itself with some kind of unalterable moral tradition, that there can be no truce between science and religion.

There does not seem to be any particular reason why a religion should not arise with an ethic as fluid as Hindu mythology, but it has not yet arisen. Christianity has probably the

most flexible morals of any religion, because Jesus left no code of law behind him like Moses or Muhammad, and his moral precepts are so different from those of ordinary life that no society has ever made any serious attempt to carry them out, such as was possible in the case of Israel and Islam. But every Christian church has tried to impose a code of morals of some kind for which it has claimed divine sanction. As these codes have always been opposed to those of the gospels a loophole has been left for moral progress such as hardly exists in other religions. This is no doubt an argument for Christianity as against other religions, but not as against none at all, or as against a religion which will frankly admit that its

mythology and morals are provisional. That is the only sort of religion that would satisfy the scientific mind, and it is very doubtful whether it could properly be called a religion at all.

No doubt many people hope that such a religion may develop from christianity. The human intellect is feeble, and there are times when it does not assert the infinity of its claims. But even then:

"Though in black jest it bows and nods

* * * * *

"I know it is roaring at the gods
Waiting the last eclipse."

The scientific worker of the future will more and more resemble the lonely figure of Daedalus as he becomes

conscious of his ghastly mission, and proud of it.

" Black is his robe from top to toe,
His flesh is white and warm below,
All through his silent veins flow free
Hunger and thirst and venery,
But in his eyes a still small flame
Like the first cell from which he came
Burns round and luminous, as he rides
Singing my song of deicides."

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